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IX. *Observations upon Lightning, and the Method of securing Buildings from its Effects : In a Letter to Sir Charles Frederick, Surveyor-General of His Majesty's Ordnance, and F. R. S. By Benjamin Wilson, F. R. S. & Ac. R. Upf. Soc.*

S I R,

**Y**OUR station, as Surveyor-General of His Majesty's Ordnance, being such, as makes the subject of this paper particularly interesting to you, I presume an apology for this address will be wholly unnecessary.

Upon an application of the Board of Ordnance to the Royal Society, in July last, a committee was appointed, to consider of the properest method for securing the *Magazine at Purfleet* from mischief by lightning : which committee reported to the council of that learned body, what they thought necessary to be done upon that occasion. The council, afterwards, transmitted to the board, a copy of that report, together with another paper written by myself, in consequence thereof.

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H

For,

For, during the consideration of that business, some doubts having arisen in my mind, with regard to the propriety of *points*, which were proposed to terminate the top of each conductor; and those doubts being founded upon experiments and observations, I could not consistently subscribe to that report, nor suppress my opinion, on a subject of such importance.

Whatever may be the sentiments of others respecting those doubts, yet, they being the result of my mature consideration, I thought it my duty to propose them to the committee; and further to express my dissent, in writing, to that particular part of their report: giving, at the same time, some of the principal reasons for such dissent; and referring them, for further satisfaction on this subject, to a letter which is already published in the Transactions of the Royal Society.

As that dissent is the origin of this paper, a copy of it is here inserted. See page 48 of this Volume.

AGREEABLE to the declaration at the end of the above dissent, I shall now proceed to offer my further reasons for objecting to pointed conductors.

Experience, which is our best guide in all physical enquiries, but particularly in electrical ones, every day convinces me, that we know but little of that subtile fluid, which operates so *secretly*, and at the same time so powerfully, upon the earth, and its atmosphere. I confess that I am even now less acquainted with the principle of its action, than I thought I was twenty years ago: the *smallest differences*

*ferences* in the circumstances of our experiments, frequently causing very material differences in their results. And perhaps no one, who has not applied his mind closely to enquiries of this kind, could conceive how the *pointing* a piece of metal, or *not*, should make any material difference in the experiment.

The electrician has it always in his power to convince any one of the fact, who, through inexperience, may be inclined to entertain the least scruple about it: for *even from those experiments* to which it was thought proper to appeal at the committee, it appeared, that the difference in the effects upon this fluid, between *pointed* and *blunted* metal, is as 12 to 1.

A thunder-cloud therefore, according to that reasoning, (the circumstances of it being supposed to be nearly similar with what is called the prime-conductor in those experiments), if it acted at 1200 yards distance upon a point, would require a blunted end to be brought within the distance of 100 yards; and beyond those limits, would pass over it, without affecting it at all. On this occasion permit me to observe, that the *longer* the conductors are above any building, the *more danger* is to be apprehended from them; as they will in that case approximate nearer in their effects to those that are pointed. And that is one reason why I was not for advising the proposed conductors at *Purfleet*, to be so high as *ten feet* above the magazines, and more particularly upon that building called the *Board-house*, which stands considerably higher than the magazines themselves.

But, before we advance farther into this subject, it may be proper to shew the reasons for introducing a

*pointed apparatus*, when the experiment upon lightning was first proposed: what good consequences were derived from that experiment: and why, upon further experiments and observations, such points ought now to be laid aside, when our intention is *not to make electrical experiments*, but by the means of conductors, *to preserve buildings from the dangerous effects of lightning*.

Dr. Franklin, in his conjectures, that lightning and electricity were one and the same fluid, considered how he should *invite*, or *bring down and collect the lightning*, so as to make experiments upon it.

And he concluded, from observation, that the likeliest method would be, to make use of such an apparatus for the purpose, as was most susceptible of electric effects; or, in other words, such an apparatus as would receive the electric fluid with the greatest ease.

Repeated experiments taught him, that *metals* had the property of receiving that fluid, with more ease than other substances.

He also learnt, from the like experience, that metals *by being pointed*, were rendered still more susceptible of receiving it.

And therefore, he proposed an experiment to be tried, “ Whether it was not in our power to invite, “ or bring down the lightning, by an apparatus, “ consisting of an *electric stand*, and an iron rod, “ twenty or thirty feet in length, rising upright “ from the middle of the stand, and at the top, “ terminating in a very *sharp point*.” This apparatus was recommended to be put upon some high building,

building, with the expectation, that if a thunder-cloud should happen to pass near this apparatus, some quantity of the lightning deposited therein would probably be collected in the rod, by means of the very sharp point, and the electrical stand at the foot of the rod

That this contrivance answered the end he first proposed, we have had sufficient evidence.

And it is no wonder if, after this great discovery, we find him, and other electricians, pursuing new experiments of this kind, and raising those points higher into the air, to collect still greater quantities of that fluid which occasions lightning. Nor need we be surprized, after knowing that lightning could be brought down from the heavens by so simple an apparatus, and after experiencing its subtle effects to be similar with the electric fluid, that the Americans, and others, upon Dr. Franklin's recommendation, adopted the principle of securing their buildings from its dangerous effects, by raising above their houses rods of iron, very *sharply pointed*, and applying *wires* from the ends of those rods, down the outside of their houses, to the ground.

But though there appeared many arguments at that time in favour of such conductors, yet experiments and observations, at last, induced Dr. Franklin to *alter his opinion* in respect to those *wires*, and to substitute in their place *rods of iron*: still retaining the principle of having the rods at the top *sharply pointed*; and many of the Americans, as well as Europeans, approved of the alteration, as appeared afterwards, from constructing their conductors accordingly.

About

About that time great attention was given, and many new experiments were made, in consequence of the frequent dangerous effects, which lightning was observed to produce in some valuable buildings, by rending and dashing to pieces very large stones and timbers, which were connected together by cramps and bars of iron : and at other times breaking and melting part of those rods, and sometimes *exploding wires*, even of a considerable thickness, like so much gunpowder.

From careful observations of these extraordinary appearances produced by violent shocks of lightning ; and upon making other experiments relating to a certain resisting power *in*, or *upon*, all bodies, which appears to act against the attacks of lightning, as well as against the electric fluid, philosophers were enabled to assign the reason, and, it is apprehended, upon a solid foundation, why Conductors should be made of *metal*, in preference to all other materials ; as the power of resisting such attacks is less in metals than in wood, stone, or marble.

And that this resistance might be the more simple and uniform, it appeared the most eligible to have the conductors made of *one continued piece of metal only*, and of *an equal diameter throughout*. But what that diameter ought to be, depended upon other circumstances, some of which are taken notice of in a former paper, referred to above, which I laid before the Royal Society.

By this historical sketch, we see the propriety of Dr. Franklin's introducing points, and the advantage philosophy has derived from them : by ascertaining

that lightning and electricity are one and the same fluid: which appears to be diffused every where, at least upon *this earth* and in *the atmosphere*.

But when *curiosity*, which I apprehend was one of the first motives for introducing points to invite the lightning, was *satisfied*; and *experience* had taught us, that we had it in our *power* to *collect* that fluid which occasions it: and when the *principle* of its action was from experiments thus investigated and *ascertained*, this manner of *invitation*, viz. by using points, ought, in my opinion, to have *ceased*\*; because a greater quantity of lightning, than we have yet experienced, may chance to attack us.

For we are so far from knowing how great the magazine of lightning may be in the heavens, or in the earth, when it is ready to discharge itself, either by one or more explosions, that we are ignorant, *even of the quantity actually discharged*, whenever any stroke from lightning visits us.

Nor can the ablest philosopher *fix the limits* of the *greatest discharge* that may possibly happen.

Seeing then how vain it is to look for any thing like *absolute security*, in all cases, it surely behoves us to proceed with *caution*. And it is for that reason I have always considered pointed conductors as being *unsafe*, by their great readiness to *collect the lightning in too powerful a manner*. And lest the conductors, without such points, should be too slender for very

\* Unless where the electrician, like *Professor Richmann* (who was killed by it) at his *own hazard*, chuses to make further observations on lightning.



violent attacks, in places of great consequence, I have always recommended the having them above *four times* larger in diameter, than what are commonly made use of, to the end our security may be the greater, by opening a larger passage for any extraordinary discharge, and so far lessening the danger to be apprehended from it.

I ought not, in this place, to omit taking notice of a paper, containing some further experiments and observations, which were produced at the committee, to shew, among other things, that pointed metals were more disposed to receive the lightning, by virtue of a *repelling principle* in the lightning, as well as the electric fluid, which acted upon the *natural quantity* of the fluid contained within the metal, at a considerable distance from the *point*, causing, if I may be allowed the expression, a kind of *vacuum* therein; but I suppose the author means to a certain distance only.

So far from disputing this philosophy, I readily admit the fact.

But, I am afraid, *every attempt* to prove that pointed conductors may be so disposed to receive this fluid more readily, will not mend the argument in the least; because, the more we lessen the power of resisting, even supposing the whole Conductor to be in that state, the more we increase the power of invitation.

In regard to other experiments, with *locks of cotton* \*, which are acted upon in a particular manner

\* Dr. Franklin's Experiments.

by the apposition of points, and the conclusions drawn from thence, in favour of pointed conductors, as causing similar effects upon the *fragments or small clouds*, which, hanging below the thunder-clouds, have been supposed a kind of *stepping-stones*, for the lightning to pass upon, towards the earth: such pointed conductors being supposed to occasion those *fragments* to retire up into the cloud from whence they were suspended; and on that account, to prevent a stroke from lightning, which might otherwise have happened, I shall, for the present, wave entering into this philosophy, as I could wish the conjecture to be reconsidered; because I apprehend it is liable to many objections, which to enumerate would carry me beyond the proper bounds of such a paper as this. However, if the same opinion should again be offered, and brought in argument, it may be worth while to enter more *deeply* into the enquiry.

If those gentlemen, who argued at the committee for the *necessity of points*, could have made it appear, that such points draw off, and conduct away, the lightning *imperceptibly* and *by degrees*, without causing any explosion, during a thunder storm (which seems to have been once the opinion of Dr. Franklin) I should readily have subscribed to their Report.

But experience shews us, that the fact is otherwise: there being many instances, where violent explosions of lightning have happened to *conductors* that were *sharply pointed*. And *three* in particular, the accounts of which are inserted in a publication of Dr. Franklin's \*, where the *points*

\* Dr. Franklin's Experiments, p. 394. 416, 417, &c.

were *dissipated*, or *destroyed*; and a small part of an iron rod melted next the points of one of them; and also at the several crooked ends of the rods below, where they were hooked on to each other, and formed the conductor belonging to Mr. Maine in North America. But as those letters are long, and contain several other curious facts, I shall reserve them, together with some further observations upon the *nature* and *power* of that *resisting principle*, which is found to act so sensibly against the attacks of the electric fluid, or lightning, to some future dissertation.

There is no building, that I know of, more exposed to this kind of danger, than the *Eddystone Lighthouse*, as it stands upon a rock in the sea, several miles from land. The fixing of a conductor to that building, was thought highly proper; and the fixing of a *point* upon it, as highly improper. It was therefore resolved upon to put up a *conductor without a point*, that no more lightning might be unnecessarily solicited to the building, and that all the lightening, which accidentally fell on it, might be conveyed away without injuring it. This conductor was *fixed* twelve years ago, and the building has since received no injury from lightning\*.

There is another edifice of great consequence, I mean *St. Paul's Church*, which stands much exposed, from its height, to accidents by lightning. The dean and chapter of that cathedral, thought it an object deserving the serious attention

\* N. B. A former building erected for the same purpose, upon this rock, was set on fire by lightning.

of the *Royal Society*. A committee was therefore appointed, in consequence of their application: and proper *conductors* were put up, in the several places where they were thought necessary, from the top of the *lanthorn* to the *sewers* underground. And notwithstanding particular care was taken, to have the additional metal either of a considerable diameter, or an equal quantity of it formed into other shapes, for the conveniency of the several places; yet part of those *conductors*, consisting of iron, in the *stone gallery*, shewed marks of their having been made *considerably hot*, if not absolutely *red*, by a stroke of lightning which happened in March last (as appears by a letter which I communicated to the *Royal Society* from one of the vergers of that church, Mr. Richard Gould) who had examined the *conductors* the morning following, along with Mr. Burton of the same cathedral \*, and that the appearances were in general,

\* Mr. Gould acquaints us in his letter, that he examined the four *conductors* in the *lanthorn* and *stone gallery* of St. Paul's Church, the morning after the lightning happened. That no marks whatsoever appeared upon the *conductor* to the *South*, which was the first he attended to. That he examined next the *conductor* to the *West*, and observed a *thick rust* lying upon the pavement in the *stone gallery*, as if it had been cleaned off, from the *conductor*, with a tool: that several parts of the iron appeared *black*, particularly the *screws* or *nuts*: something like the effects left by gun-powder upon iron or steel, or a smoaky fire.

That the *conductor* to the *North*, shewed no marks, no more than that to the *South*.

But that upon examining the *conductor* to the *East*, he found stronger marks *abundantly*, than on the *West* *conductor*,

ral, as the verger's letter related them to me. Mr. Delaval and myself attended, about a week afterwards, to observe them, and their particular

it being *much blacker* ; particularly on the nuts and screws : the rust lying in greater quantities on the pavement. *And the extreme part of the conductor that goes into the water trunk*, seemed like a piece of iron *newly taken out of a forge* by a smith, without working it on the anvil.

N. B. Mr. Gould has since added to the account in his letter, some circumstances which I apprehend ought not to be omitted. He says, that where the end of the conductor, on the East side, points towards the water trunk, a stone surrounds part of it, leaving an interval, half an inch wide or more, between them, and about four or five inches long, which is a little more than the breadth of the conductor. That this interval was *filled up with dirt*, and had been so for some time, occasioned by frequent showers of rain washing the pavement in the stone-gallery. That, after the lightning happened, he observed a *hole* was made through the *dirt*, *one quarter of an inch in diameter*, and about *two inches in length*. That the hole was close to the iron ; and that, upon stooping down his head, he perceived a very disagreeable *smell of sulphur* from the stone, dirt, and conductor, particularly the last.

Upon hearing this account, Mr. Delaval and myself, a few days ago, went and examined the conductors again ; but more carefully than before. For, upon causing the stone to be removed, which covered the top of the water trunk, we had an opportunity of examining near two feet more of the iron which points to the water trunk, than we could perceive before this stone was removed. When we observed, that the conducting iron did not touch the lead. We likewise observed, that there was a *very thick coat of rust* all over that part of the iron ; *particularly at the end next the lead*, where the water entered the trunk.

As the necessity of attending to these circumstances will be obvious to any one, who is but in the least degree acquainted with these researches, *the danger of neglecting them will be seen in the strongest light*, by the gentlemen of the committee who recommended the conductors for the security of that Cathedral.

situations,

situations ; with the circumstances attending them, when we were very well satisfied with his account, notwithstanding it had rained in the *interim* for three days together.

It is worthy of note, that those conductors did *not terminate in a point*, nor was any *point put* upon the *cross at the top*.—And yet Dr. Franklin was of that committee.

If points are so essential to our safety, why was not the reason enforced at the committee, for having them on that capital edifice ? For my part, I think it was a happy circumstance, that there was *no point* fixed upon the top of the church, to solicit a greater quantity of lightning at that moment, than what fell upon the conductors, circumstanced as they were: as *that quantity* was great enough to *beat so considerably a bar of iron*, near *four inches broad*, and about *half an inch thick*.

This powerful effect, reminds me of another instance still more extraordinary, which happened in Martinico, and is related by *Captain Dibden*, where a bar of iron, *one inch in diameter*, was by a violent shock of lightning *reduced in one part of it, to the thickness of a slender wire only*. See Ph. Tr. Vol. LIV. p. 251.

Since then we are at all times ignorant of the quantity of *lightning in the earth* and its atmosphere ; and the difference in the effects, between blunted and pointed, ends, in causing a discharge in our electrical experiments, appears to be as *one to twelve* ; it is easy to comprehend the very great danger this noble fabrick has probably escaped, by having no pointed apparatus upon it.

From

From the above observations, I am naturally led to consider a part of the proceedings of the committee, respecting the *magazines* at *Purfleet*; when a certain number of conductors, with tapering points at the top, were resolved upon, as necessary, to protect the several buildings where the powder is deposited. For it was *agreed* upon at the same meeting, that the *Board-house*, which is a large building for the use of the board-officers, and which stands considerably higher than the magazines, as was observed above, *did not require any point at the top*: because it was apprehended to be *perfectly secure*, by reason of the copings on the roof, the gutters and pipes to carry off the water, being all of lead: and further, because those pipes communicated with two wells, which always contained water.

I was not a little surprized at this last resolution, which appeared to be so inconsistent with the former. Because, if points were necessary in one place, they ought to be so in another. And on the other hand, if the Board-house is secure by the leaden accidental conductors, which have no points, why ought not the magazines to be equally secure, when put into the same circumstances?

I therefore enforced the *inconsistency* of such a resolution in the strongest terms. Notwithstanding which, the gentlemen, at that time, thought proper to confirm their resolution. However, at the next meeting of the committee, I observed that they had been pleased, in the mean time, to make an amendment in favour of points for the board-house;

house ; which amendment was no sooner proposed, than approved of.

Why my observation was rejected at the preceding meeting, I must leave to the judgment of others. But it certainly carries an appearance, as if *manifest contradiction*, upon further reflection, must have been the *cause* of that alteration.

And I am inclined to believe, from some gentlemen of the committee expressing their opinion, “ *of its being a matter of mere indifference whether* “ *blunted or pointed conductors were made use of,*” that they have not considered this subject, with all the due attention which so important an object deserves.

For if our experiments shew, that *points*, from the *nature* of their *shape*, and *other* circumstances attending them, resist the attacks of this fluid less than blunted ones ; and that blunted conductors, of proper dimensions, are sufficient to convey away the lightning *safely*, whenever it attacks them ; why should we have recourse to a method, which is at best uncertain ; and which some time or other may be productive of the most fatal effects ?

But perhaps no argument can be brought with more force against the principle of points, than Dr. Franklin’s own words, which are published in his experiments, p. 481, where he declares *positively*. “ Buildings, that have their roofs covered with “ lead, or other metal, and spouts of metal continued from the roof into the ground to carry off “ the water, *are never hurt by lightning* ; as whenever it falls on such a building, it passes in the “ metals, and not in the walls.”

This



This is the case with the *British Museum*, a building also of considerable consequence, where there are no other *conductors*, than what are formed by the *copeings, gutters and pipes*, which are all of lead, and communicate with the ground. Now it is from the great quantity of metal contained in the several pipes, together with the other circumstances attending them, that I considered that building (in a former paper laid before the royal society) as being sufficiently secured, from those dangerous accidents.

But if any gentleman should be disposed to entertain a doubt about it, or indeed of any other part of my reasoning on this subject, a *declaration* of those doubts may be attended with good consequences, as they will necessarily open the door to a more minute investigation.

I have now, Sir, gone through the reasons which I proposed to lay before the royal society for the rejecting of points. And I am very sorry, in the course of this letter, to have been under the necessity of mentioning any differences in opinion, which passed between the members of the committee, to whom this important matter was referred. I think, however, I shall stand excused to the society, and the public, when it appears, as I hope it now sufficiently does, what my motive has been; namely, to state clearly, and impartially, the objections which I conceived to lye against pointed conductors: and to disclose *without any reserve*, the principles on which such objections are grounded.

I am, S I R, with the greatest respect,

Your most obedient, and most humble servant,

8th December, 1772,  
Great Russel-street,  
Bloomsbury.

Benjamin Wilson.

P. S.

P. S. Mr. Delaval, who was one of the committee, has given me leave to insert his opinion upon this subject; which is this. That he concurs with me in thinking that such conductors as are elevated higher than the buildings to which they are applied, or are pointed at the top, are *improper* and *dangerous*.

He was desirous of delivering his opinion at the committee: but, as the meetings of it were held in the summer only, his absence from London prevented his attendance.